REMARKS

The Examiner's action mailed on May 24, 2002 has been received and its contents carefully considered.

Claims 20, 22 and 24-31 are pending in this application. Claim 30 is cancelled without prejudice or waiver. Claims 20, 26 and 28, the independent claims, are amended herein. The changes to the amended claims are shown in the Appendix to this Amendment with deletions indicated by bracketing and additions by underlining.

Claims 26 and 28, and claims 27 and 29-31 as being dependent on them, stand rejected under 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention. Specifically, the Examiner point to the terms "distances are set such that upon application of the heat treatment to the device, the bumps of the first bump unit melt so as to become connected and fuse to each other as a unitary body," in claims 26, and "bumps of the first bump unit are sufficiently close to each other that upon the application of the heat treatment to the device, the bumps of the first bump unit fuse into a unitary body," in claim 28, as being relative terms that render the claims indefinite. The Examiner argues that the terms are not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention.

The applicant disagrees. The terms in the claims to which the Examiner refers are functional limitations, i.e, an attempt to define something by what it does, rather than what is, such as its specific structure or composition. As indicated in MPEP §2173.05(g), there is nothing inherently wrong with defining some part of an invention in functional terms. Functional language does not, in out itself, render a claim improper. The question to be considered, just as with any other claim limitation, is what the limitation fairly conveys to a person of ordinary skill in the pertinent art in the context in which it is used. It is respectfully submitted that, in this case, a person of ordinary skill in the art could readily determine what spacing, or range of spacings, of the bumps in the first bump unit would be sufficiently close that the bumps would fuse into a unitary body upon application of the heat treatment. Contrary to the Examiner's argument, the specification does provide, on page 5, lines 26-28, an example of when the bumps in the first bump unit could be

considered "sufficiently close." In fact, the Examiner himself argues, in connection with claim 31 (see pages 5-6 of the Action), that it would have been an obvious matter of design choice to make the distance between the bumps in the bump first bump unit about 1 to 1.4 times the diameter of the bumps, since such a changes in size is generally recognized as being within the level of ordinary skill in the art. Hence, is respectfully submitted that claims 26 and 28 are not indefinite under the standards enunciated in MPEP §§2173.05(b) and 2173.05(g). Reconsideration and withdrawal of the Examiner's §112, second paragraph, rejection is requested.

Claims 20, 22 and 24-29 stand rejected under 35 USC §103(a) as being obvious over Katchmar (U.S. Patent No. 6,194,782 B1), in view of Bond et al. (U.S. Patent No. 5, 642,261). The rejection is respectfully traversed.

In the Action, the Examiner asserts that Katchmar teaches a semiconductor device, Figures 1-5, comprising: a substrate 12 having a main surface 14 and a back surface 16, wherein said back surface 16 has a central area 32, an intermediate area surrounding said central area 32 and a peripheral area surrounding said intermediate area; a semiconductor chip 18 formed on said main surface; a first bump unit formed of solder bumps 40, Figure 5, disposed at a first distance from each other and located in said central area of said back surface, wherein said first bump unit radiates heat from said semiconductor device; a second bump unit formed of solder bumps 24 and located in said peripheral area of said back surface, wherein said second bump unit transmits signals (column 6, lines 50-53), wherein the second bump unit is greater in quantity of solder balls than the first bump unit, and said solder balls are spherical in shape. Further, the Examiner asserts that Katchmar teaches a first distance between connection solder balls being greater than a second distance between heat transfer solder balls (column 7, lines 39-47). Further yet, the Examiner points to Katchmar as teaching that said central area could be thermally connected to said circuit board by a solid melted solder mass 26.

Contrary to the Examiner's assertions, it is respectfully submitted that Katchmar fails to teach or suggest a distinct intermediate area between the central area and the peripheral area, as required by the rejected claims. What Figures 1-4 disclose, for example, is a ball grid array with uniform spacing in which the solder mass 26 replaces the solder balls in the area under the semiconductor chip 18, and only in that area, and the remainder

of the bottom surface 16 of the substrate 12 comprises a peripheral area, available for placement of solder balls (column 6, line 66, through column 7, line 3) for signal transmission purposes. In Figure 5 of Katchmar, a plurality of closely spaced solder balls 40 replaces the single solder mass 26 under the semiconductor chip (column 7, lines 39-48). However, unlike the present invention, none of the embodiments described in Katchmar disclose a distinct intermediate area, marked by a lack of solder balls, between the central area and the peripheral area.

The Examiner acknowledges that Katchmar fails to teach that the second distance (between the bumps of the second bump unit) is less than the width of the intermediate area, and that the melted solder mass (unitary body) can be made by locating bumps of the first bump unit sufficiently close to each other that upon application of the heat treatment to the device, the bumps of the first bump unit will fuse together. To cure this defect in Katchmar, the Examiner points to Bond as teaching a semiconductor device 8, Figures 1-6, comprising: a substrate 14 having a main surface and a back surface, wherein the back surface has a central area, an intermediate area surrounding the central area, and a peripheral area surrounding the intermediate area; a semiconductor chip 10 formed on the main surface; a first bump unit formed of solder bumps 18 disposed at a first distance apart from each other, and located in the central area of the back surface, wherein the first bump unit radiates heat from the semiconductor device; a second bump unit formed of solder bumps disposed at a second distance apart from each other and located in the peripheral area of the back surface, wherein the second bump unit transmits signals, the second distance is greater than the first distance, the second distance is less than a width of the intermediate area, and the second bump unit is greater in quantity of solder balls than the first bump unit, the solder balls being spherical in shape. The Examiner also asserts that Bond discloses in Figure 2, bumps 18 of the first (central) bump unit located so close to each other that upon application of the heat treatment to the device, they will obviously fuse into a unitary body. The Examiner argues that it would have been obvious to one skilled in the art at the time the invention was made to employ a second distance being less than a width of the intermediate area, and to locate bumps of the first bump unit so close to each other that upon application the heat treatment to the device the bumps of the first bump unit will fuse into a unitary body as shown by Bond in the device of Katchmar in

order to avoid shorting between the thermal and signal solder balls while applying heat to melt the thermal solder balls into a unitary body, and to enhance heat dissipation by a central group of solder balls.

Regarding the intermediate area and its width relative to the spacing of the bumps in the peripheral area, the Examiner has attached to the Action copies of Katchmar Figure 5 and Bond Figures 1 and 2, marked by the Examiner to show the various areas and distances recited in the claims. Attached to this document, as attachments A & B, are the figures from Katchmar and Bond that the Examiner has marked up. Applicant has further added letters "c" and "d" to each figure to designate the width of the intermediate area marked by the Examiner, and the distance between the bumps of the second bump unit, respectively. As the Examiner acknowledges, the width of the intermediate area, c, in Katchmar is clearly less than the distance between the bumps in the peripheral area, d. While the Examiner has been maintaining that the space between the bumps in the central area and the bumps of the peripheral area correspond to the intermediate area recited in the claims, it is respectfully submitted that there is nothing about that space to distinguish it from the peripheral area or to indicate that is if not simply part of the peripheral area itself. There is nothing disclosed in the text of Katchmar to suggest an intermediate area; only that the solder balls under the semiconductor die (i.e., in the central area) are placed in closer proximity to each other than those not positioned under the die (i.e., in the peripheral area) (see column 7, lines 42-44).

Contrary to the Examiner's position, it is respectfully submitted that Figure 1 of Bond also discloses that the distance c is less than d. The text and figures of Bond fail to disclose an intermediate area; they disclose only that the area under the slug 12 has solder balls 18 to conduct heat away from the semiconductor die 10 (column 4, line is 34-37), and the area not under the slug has an array of solder balls to provide signal connections (column 4, lines 12-20). Unlike Katchmar, Bond fails entirely to disclose any relationship between the spacing of solder balls in the peripheral and central areas. By contrast, the present application, in Figures 1 & 2, attached to this Amendment as Attachment C, discloses a very well-defined intermediate area having a width, c, distinctly larger than the space between the solder balls, d.

As noted above, the Examiner relies on Bond to satisfy the requirement that the bumps of the first bump group melt and fuse together upon application of heat. It is respectfully submitted that the solder balls under the integrated circuit chip are shown out of scale for clarity in the plan view of Figure 2, and that the more accurate representation is the section view of the same embodiment in Figure 1, where the solder balls in the central area do not appear to be any closer together than those in the peripheral region. There is nothing elsewhere in Bond to even suggest having the solder balls in the central area close enough together to melt and form a unitary body when heat is applied. In fact, the embodiments shown in Figures 3-6 of Bond utilize solder masks 37, 81 that would prevent the formation of a unitary body of solder. Thus, if anything, Bond teaches away from this advantageous feature of the present invention.

Considering the foregoing, it is respectfully submitted that Bond fails to cure the acknowledged defects in Katchmar, and that claims 20, 26 and 28, as well as their respective dependent claims, distinguish over the applied art references, whether taken individually or in combination.

Each of claims 20, 26 and 28 are amended to make it clearer that the intermediate area is an area in which no bumps are located. Claim 28 is a further amended to incorporate the express limitation, from cancelled claim 30, that the second distance between the bumps of the second unit, is less than the width of the intermediate area.

All of the claim rejections having been addressed, it is respectfully submitted that the application, as amended, is in condition for allowance. Notice of such, with allowed claims 20, 22 and 24-31, is earnestly solicited.

(Continued next page)

Should the Examiner believes that an interview would be helpful in resolving any open issues regarding this application, the Examiner is respectfully invited to call the undersigned attorney to schedule of such an interview.

Respectfully submitted,

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Appendix

Attachments A-C

APPENDIX

AMENDMENTS TO CLAIMS

(Deletions indicated by bracketing and additions by underlining)

20. (Twice Amended) A semiconductor device, comprising:

a substrate having a main surface and a back surface,

wherein said back surface has a central area, an intermediate area in which no bumps are disposed, surrounding the central area, and a peripheral area surrounding said intermediate area;

a semiconductor chip disposed on said main surface;

a first bump unit disposed in said central area of said back surface,

wherein said first bump unit includes a plurality of bumps that are disposed a first distance apart from each other, and

wherein said first bump unit radiates heat from said semiconductor device; and

a second bump unit formed in said peripheral area of said back surface,

wherein said second bump unit includes a plurality of bumps that are disposed a second distance apart from each other, said second distance is greater than said first distance, and said second distance is less than a third distance between said central area and said peripheral area, and

wherein said second bump unit transmits signals.

26. (Amended) A semiconductor device, comprising:

a substrate having a main surface and a back surface, the back surface having a central area, an intermediate area in which no bumps are disposed, surrounding the central area, and a peripheral area surrounding the intermediate area;

a semiconductor chip disposed on the main surface;

a first bump unit disposed in the central area of the back surface to radiate heat from the semiconductor device, the first bump unit including a plurality of bumps disposed a first distance apart from each other; and

a second bump unit formed in the peripheral area of the back surface for transmitting signals, the second bump unit including a plurality of bumps disposed a second distance apart from each other, the second distance being greater than the first distance and less than a third distance between the central area and the peripheral area,

wherein the first and second distances are set such that upon application of a heat treatment to the device, the bumps of the first bump unit melt so as to become connected and fuse to each other as a unitary body and the bumps of the second bump unit melt and remain apart from each other.

28. (Thrice Amended) A semiconductor device, comprising:

a substrate having a main surface and a back surface, the back surface having a central area, an intermediate area in which no bumps are disposed, surrounding the central area, and a peripheral area surrounding the intermediate area;

a semiconductor chip disposed on the main surface;

a first bump unit disposed in the central area of the back surface to radiate heat from the semiconductor device, the first bump unit including a plurality of bumps disposed a first distance apart from each other; and

a second bump unit formed in the peripheral area of the back surface for transmitting signals, the second bump unit including a plurality of bumps disposed a second distance apart from each other sufficient to assure that upon application of a heat treatment to the device causing the bumps of the first and second bump units to melt, the bumps of the second bump unit remain apart from each other, the second distance being greater than the first distance and less than a width of the intermediate area;

wherein the bumps of the first bump unit are sufficiently close to each other that upon the application of the heat treatment to the device, the bumps of the first bump unit fuse into a unitary body.

ATTACHMENT A

Katchmar

$e > a$

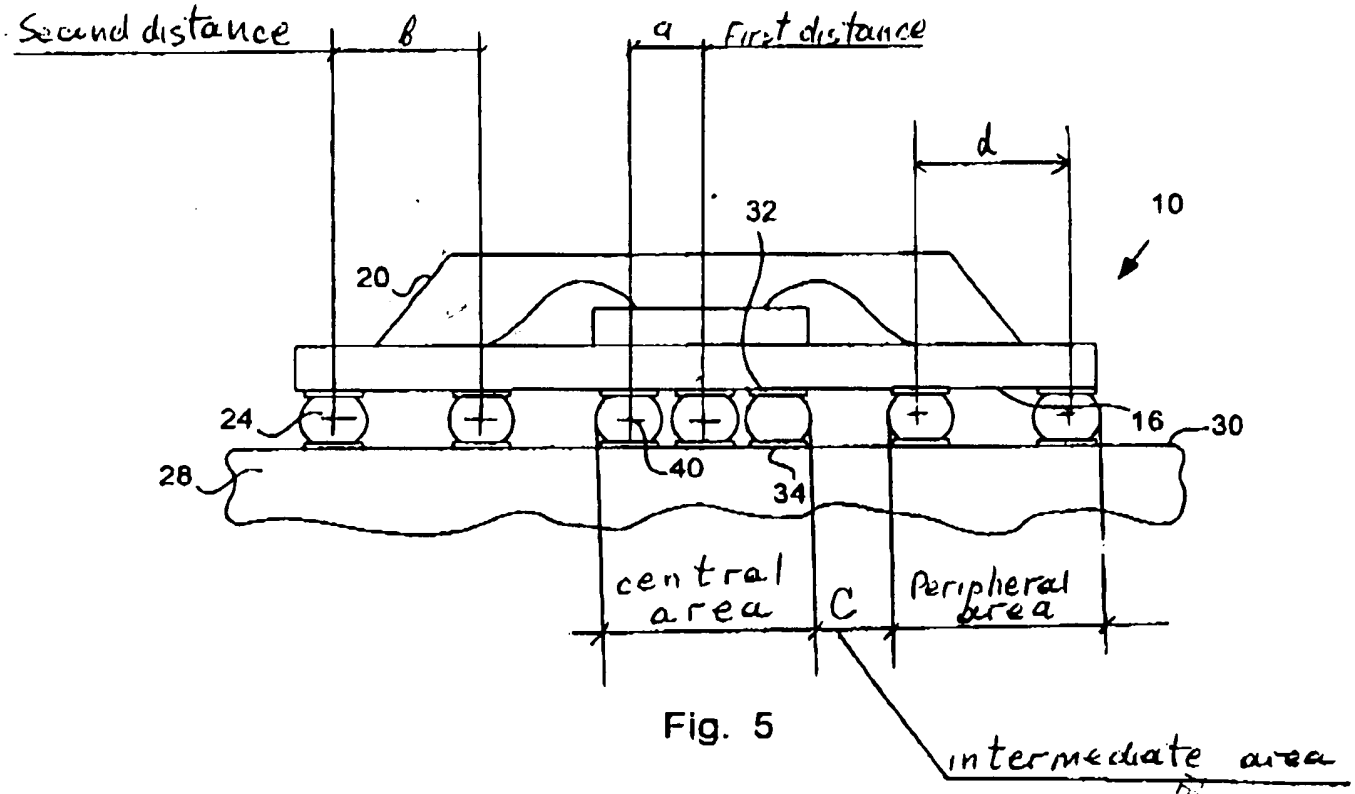

Fig. 5

$C < d$

ATTACHMENT B

Bond et al

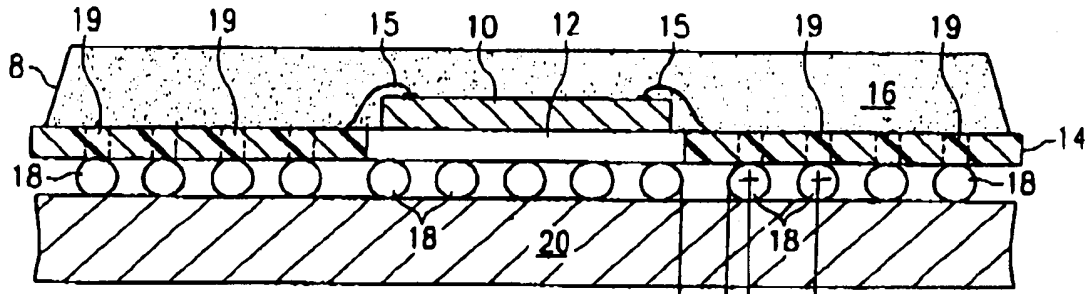

FIG. 1

Width of the intermediate area → c

Second distance → d

c < d

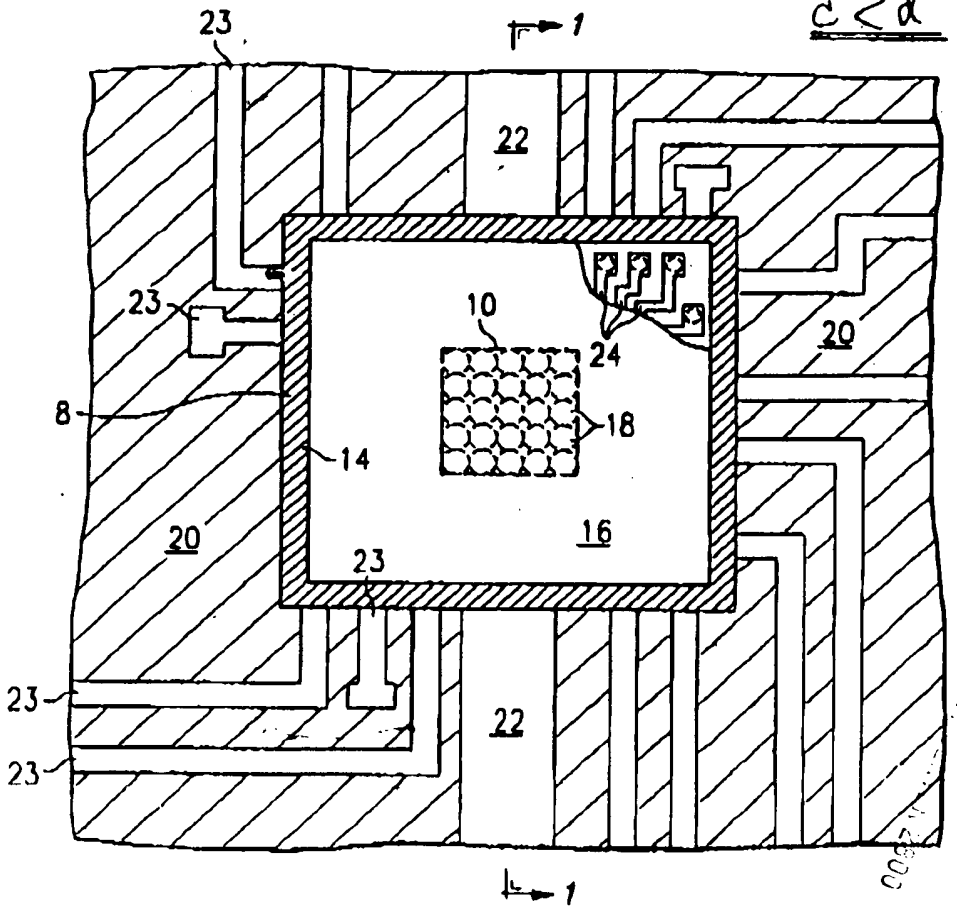

FIG. 2

ATTACHMENT C

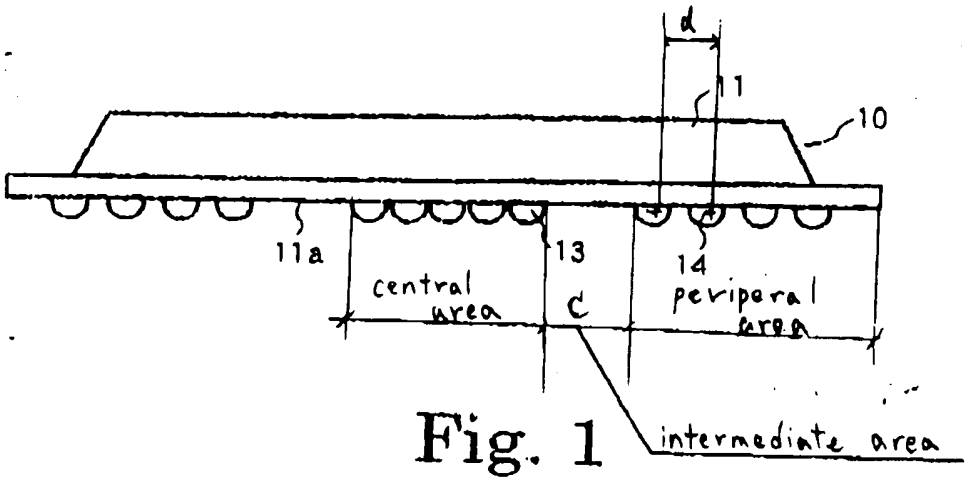

Fig. 1

C > d

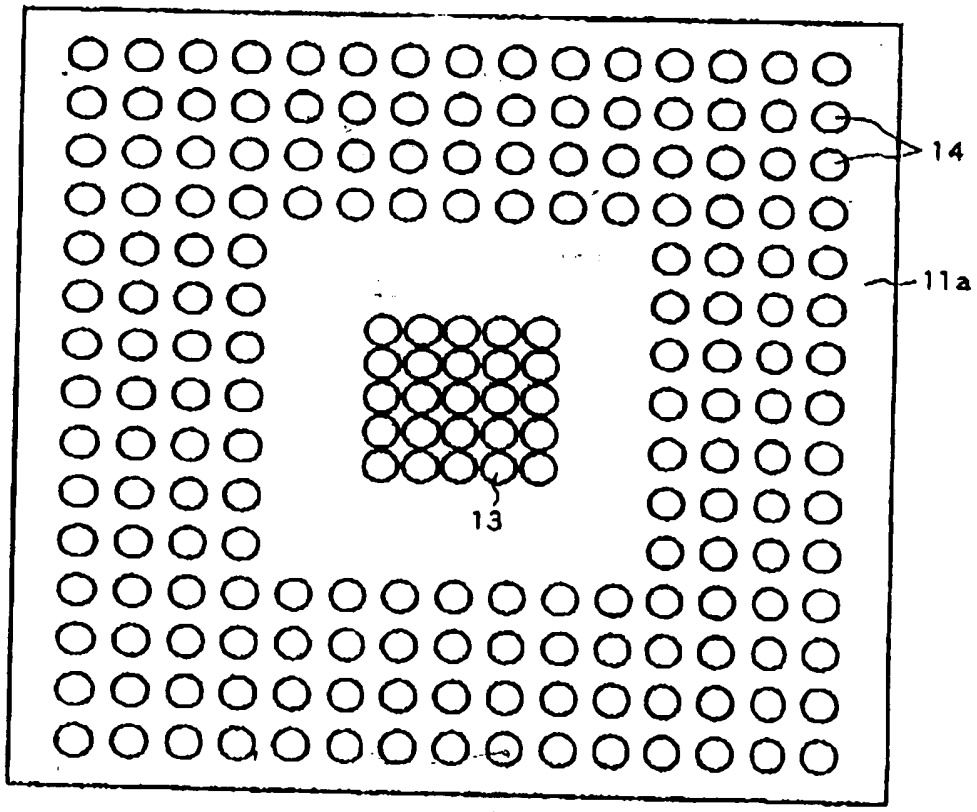

Fig. 2